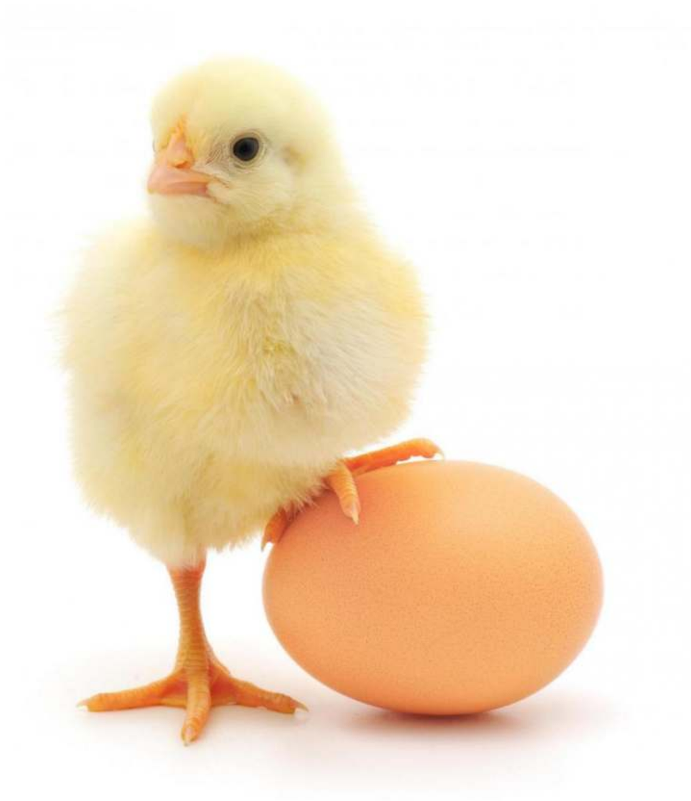
ISSN 1682-8356
ansinet.org/ijps



INTERNATIONAL JOURNAL OF POULTRY SCIENCE

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

International Journal of Poultry Science 3 (7): 456-462, 2004

Post Molt Performance Parameters of Broiler Breeder Hens Associated with Molt Induced by Feed Restriction, High Dietary Zinc and Fasting

A.A. El-Deek and M.A. Al-Harthi[1]
Poultry Production Department, Faculty of Agriculture, El-Shatby, Alexandria University, Egypt
[1]Faculty of Meteorology Environment and Arid Land Agriculture, King Abdulaziz University, Saudi Arabia

Abstract: Four hundred and eighty broiler breeder hens from a commercial flock of Hubbard broiler breeders was utilized in this experiment. The flock was reared for 19 weeks after which it was transferred to production houses. Egg production was commenced at the 24th week of age and egg production reached 80.2%. Hens at 57 weeks old and egg production of 46% were randomly selected from the production flock and were transferred to an open-house containing 15 floor pens (3 X 2.4 m.). Hens were randomly assigned to four force molting treatments, which were as follow: 1) feed and water restriction, 2) 20.000 ppm Zn as zinc oxide addition to the layer diet "16% CP", 3) 30.000 ppm Zn as zinc oxide addition to the layer diet "16% CP", and 4) fasting. The experimental period was divided into 4-periods, 1) From 1- day old till 14 day of age, 2) 15 till 32 days, 3) 33 to 58 days, and 4) 59 to 129 days of age. Results revealed that during the 1st experimental period, ZnO 3% and fasting treatment were significantly ($p<0.05$) higher in body weight losses (21%). Furthermore, ZnO addition to layer feed reduced feed consumption significantly. No effects of treatment were observed regarding the digestive system parameters. In the 2nd period of the study, body weights decreased with the ZnO 2%, feed restricted, and ZnO 3% (8.9, 4.9 and 4.4%) respectively. However, body weight in the fasting group increased (+14.5%). During the 3rd experimental period, body weight increased with all force molting treatments with the highest of the fasted group. No significant differences ($p>0.05$) were observed in the reproductive system parameters including ovary weight. However, oviduct weight of the ZnO 3% contributed the highest weight 3.53 g/1000 g body weight.

Key words: Molting, breeder hens, feed restriction, zinc

Introduction

Forced molting is an economic practice of laying hens to extend their productive life. Since 1960's, forced molting has become the dominant replacement program for the U.S. egg industry (Ahmad and Roland, 2003). Age at flock sale has grown from 75 to 105 wk for two cycle flocks, and more than 125 wk for three cycle flocks (Bell, 1995). In 1987 it was estimated that approximately 60 percent of hens nationwide and 90 percent of hens in California were force molted (Holt, 1993). According to USDA published data (1996), at any given time in the United States over six million hens are being molted by the poultry and egg industries. Feeding molted hens is a challenge to sustain their optimum production performance and retain essential body nutrients at the same time. Yet the commercial White Leghorn layers (molted or non molted) are generally phase fed with subsequent adjustment based upon their daily feed intake levels. Egg producers have streamlined such feeding methodologies with little or no changes even under dynamic market conditions.

Using high level of dietary zinc is an effective method of inducing rest for laying hens by Scott and Creger (1997), and Berry and Brake (1987). Force molting of layers is used as a management technique to avoid the annual cost of replacing pullets. Force molting, which is characterized by cessation of egg production for several weeks, may improve rate of production during post-using zinc oxide (McCormick and Cunningham, 1984; Berry and Brake, 1987; Mohamed, 1987; Mohamed, 1990; Hassan, 1996).

The objectives of this research however, were to:

1. Determine the best method of force molting on the performance of molted hens, and
2. Study the effect of these molting methods for maximum profits using molted Hubbard® broiler breeder hens.

Materials and Methods

A commercial flock of Hubbard broiler breeders (480 hens) was utilized in this experiment, which was conducted at a private sector poultry production commercial farm. The flock was reared for 19 weeks after which it was transferred to production houses. At production houses, male addition was done at the day of transportation at a rate of 1-cock/10 hens. Egg production was commenced at the 24th week of age and egg production reached 80.2%. Hens at 57 weeks old and egg production of 46% were randomly selected from the production flock and were transferred to an open-house containing 15 floor pens (3 X 2.4 m.). The flock was fed a layer diet 16% CP at 155 g/bird/day (Table 1), and exposed to 17 hours of artificial light/day.

Hens were randomly assigned to four force molting

Table 1: Layer diet composition and calculated analysis

Ingredients	(%)
Corn Yellow,	67.00
Soybean Meal, (44%)	12.00
Wheat Bran, (14%)	4.00
Meat bone meal,	7.00
Limestone,	7.60
Fish meal, (72%)	1.00
Bone meal,	0.75
Salt,	0.20
Premix[1],	0.40
Methionine,	0.05
Total	100.00
Chemical Analysis:	
CP,	16.00
Fiber,	3.94
Moisture,	8.70
Ash,	11.95
Nutrient Calculated Analysis	**(%)**
CP,	16.24
M.E, kcal/kg	2800.84
Fiber,	3.008
Fat,	3.177
Ash,	11.314
Calcium,	3.484
Total P.,	0.629
Available P.,	0.430
Methionine,	0.350
TSAA,	0.590
Lysine,	0.852
Salt,	0.371
Moisture,	9.883

[1]Vitamin and minerals premix provided per kilogram of the diet: Vit. A, 12000IU; D_3, 2000ICU; Vit. E, 10mg; Vit K, 2mg; B_2, 4mg; pantathonic, 10mg; Nicotonic, 20mg; Folic, 1mg; Biotin, 50mcg, Choline chloride, 500mg; Copper, 10mg; iron, 30mg; manganese, 55mg; Zinc, 55mg, and Selenium, 0.1mg.

treatments, each consisted of three replicates with forty birds each. Force molting treatments were as follow: 1) feed and water restriction, 2) 20.000 ppm Zn as zinc oxide addition to layer diet "16% CP", 3) 30.000 ppm Zn as zinc oxide addition to layer diet "16% CP", and 4) fasting. The experimental period was divided into 4-periods, 1) from 1- day old till 14 day of age, 2) 15 till 32 days, 3) 33 to 58 days, and 4) 59 to 129 days of age. Treatments arrangement within each period is presented in (Table 2).

Feed consumption FC, and daily egg production were recorded daily throughout period one till zero production was achieved. Hens were weighed at the 1st, 14th, 32nd and 56th days of age, body weight gains and loss were calculated. At days 14, 32 and 58, 3 hens from each treatment were randomly selected and slaughtered whereas digestive system parameters were studied including abdominal fat, liver, intestine weights and intestine length. Also, the reproductive system was studied measuring the length and weight of the oviduct and ovary.

Reaching the 4th experimental period, number of days to the first egg was measured for each treatment and subsequent egg production was recorded daily. Calculating the hens day H.D.%, and hen housed H.H.% production as follow:

H.D.% = [(Number of eggs produced/week)/(Number of live hens)] x 100

H.H.% = [(Number of eggs produced/week)/(Number of housed hens)] x 100

Eggs were weighed for average egg weight. Egg quality "5 eggs/treatment" was conducted for measuring the deformation and shell thickness twice a week.

Data were tested for significance using the analysis of variance, GLM of SAS® (1996) and where applicable differences among treatments were tested by Duncan's multiple range test (Duncan, 1955; Snedecor and Cochran, 1967).

Results and Discussion

Applying force molting methods, and its effects on broiler breeders performance are presented in Table (3). Feeding ZnO at 3% and fasting for 14 days resulted in significantly ($p<0.05$) higher body weight loss as compared to other molting methods. These results are in agreement with those of Palafox and Elodie (1980), who reported a 15.9% reduction in body weight for pullets fed 20 mg/g ZnO. Also, McCormick and Cunningham (1984) reported a 17% reduction in body weight for pullets fed ZnO at 2%. It is not clear what the optimum body weight loss of hens should be during an induced molt. However, our results reported herein are in disagreement with those of Ahmad and Roland, (2003), of which authors reported no significant effects of feed restriction on molted Dekalb Delta® hens on their body weights or feed consumption. Baker *et al.* (1983), reported that body weight losses of 27-31% resulted in optimum post molt performance when the molt was induced by various fasting and photoperiod manipulation. If these levels are representative for optimum body weight loss for molted birds, then the restricted, 2% ZnO, 3% ZnO and fasting methods employed here resulted in less than optimum weight loss. Nevertheless, our data reported herein dealt with broiler breeder hens compared to laying hens used in the work of Baker *et al.* (1983). The great decline in body weight of ZnO 3% and fasting might be due to decrease in muscle mass, utilization of adipose tissue, decrease in liver weight and involution of the reproductive organs compared to other treated groups. Identical results were reported by Brake and Thaxton (1979) and Berry and Brake (1985). The 2% ZnO group consumed significantly higher amounts of feed, as compared to the ZnO 3%

Table 2: Experimental design and treatment arrangement

Period	Treatment			
	1	2	3	4
1st period	Skip a day program 45g/bird/day+ water	Zn O at 20.000 ppm 155 g/bird/day + water	Zn O at 30.000 ppm 155 g/bird/day + water	Fasting +water
2nd period		50% of full feed 75 g/bird/day		Cracked corn *ad libitum* 50% of feed
3rd period		75% of full feed 115 g/bird/day		
4th period		100% of full feed as the manual recommends		

Table 3: Effect of force molting methods on the performance of broiler breeder hens throughout the entire experimental period

Treatment	Body weight		Body weight loss		Feed consumption	Mortality
	Initial	Final	g	%	g/hen/day	%
Day 1-14						
Feed restriction	3511^{c}±22.09	2879^{b}±22.07	640^{b}±20.49	18	-----	2.5
ZnO, 2%	3624^{a}±21.81	3041^{a}±21.23	581^{c}±19.53	16	62.0±7.93	2.5
ZnO, 3%	3653^{a}±19.69	2891^{b}±17.80	771^{a}±17.12	21	33.3±4.09	0.00
Fasting	3563^{b}±22.82	2802^{c}±19.40	744^{a}±20.81	21	-----	0.8
Day 15-32						
Feed restriction	2879^{b}±22.07	2807^{b}±34.18	98.2^{b}±25.88	3.4	75.0^{a}±0.00	0.0
ZnO, 2%	3041^{a}±21.23	2846^{b}±28.03	233.7^{a}±24.36	7.7	71.8^{b}±1.23	2.6
ZnO, 3%	2890^{b}±17.80	2765^{c}±24.85	139^{b}±27.15	4.8	72.6^{b}±0.58	0.0
Fasting	2802^{c}±19.40	3205^{a}±24.69	406^{c}±20.73	+14.5	73.0^{b}±0.18	0.0
Day 33-58						
Feed restriction	2807±34.18	2954±34.29	75±40.37	2.7	115±0.0	2.6
ZnO, 2%	2846±28.03	2985±30.90	149±37.49	5.2	115±0.0	2.7
ZnO, 3%	2765±24.85	2939±32.35	149±42.67	5.4	115±0.0	3.3
Fasting	3205±24.69	3240±36.35	48±44.16	1.5	115±0.0	0.0s

Means in each column with different superscripts are significantly different ($p<0.01$).

Table 4: Effect of force molting methods on the daily egg production of broiler breeder hens throughout the 1st experimental period (day 1-14)

Day	Restricted feed	ZnO 2%	ZnO 3%	Fasting
1	27	36	31	27
2	25	37.5	23	23
3	20	26	11	23
4	8	19	4	14
5	4	12	2	5
6	3	9	2	3
7	0.9	3	8	0.9
8	0	6	0.8	0
9	0	1.7	0.8	0
10	0	0	0	0
11	0	1.7	0	0
12	0	0	0	0

group 62.0 vs. 33.3 g/hen/day respectively. These results are similar to those of and Shippee *et al.* (1979), who obtained a 65% reduction in FC for SCWL hens fed 10.000 ppm ZnO for one week. Also, Scott and Creger (1976) noted that broiler and laying hens can tolerate up to 14.000 ppm dietary Zn before showing any toxicity symptoms. There were no significant differences in mortality for hens exposed to any of the four force molting methods employed.

During the 2nd experimental period (15-32 days), body weights and FC were significantly affected ($p<0.05$) by inducing force molting using four methods. Fasted hens showed a 14.5% body weight increase as a result of feeding them on cracked-corn for the first 10 days of the 2nd period. These results are in contrast with those reported in the 1st experimental period with the same treatment. ZnO 2% showed the greatest body weight loss of 7.7%, and the lowest FC 71.8 g/hen/day. These

Table 5: Effect of force molting methods on the reproductive system of broiler breeder hens throughout the entire experimental period

Treatment	Ovary	Oviduct	
	weight g/1000 gbw	weight g/1000 gbw	Length cm
Day 1-14			
Feed restriction	1.53±0.13	5.27[b]±0.23	11.30±1.00
ZnO, 2%	2.00±0.40	7.57[a]±0.52	5.50±0.21
ZnO, 3%	1.50±0.15	5.50[b]±0.21	14.20±1.04
Fasting	1.77±0.32	5.90[b]±0.57	13.90±1.35
Day 15-32			
Feed restriction	0.90±0.17	2.57±0.18	7.97±0.55
ZnO, 2%	1.57±0.37	2.37±0.03	6.20±2.62
ZnO, 3%	1.17±0.19	2.07±0.55	9.47±1.50
Fasting	0.33±0.12	2.07±0.74	7.23±1.95s
Day 33-58			
Feed restriction	1.03±0.24	0.93[b]±0.12	7.10±0.42
ZnO, 2%	1.07±0.09	1.13[b]±0.03	6.53±0.12
ZnO, 3%	1.10±0.06	3.53[a]±0.66	7.10±2.10
Fasting	0.90±0.10	1.10[b]±0.06	5.90±0.15s

Means in each column with different superscripts are significantly different ($p<0.01$)

Table 6: Effect of force molting methods on the digestive system[1] of broiler breeder hens throughout the experimental period

Treatment	Abdominal fat wt.	Gizzard wt. g/1000 gbw	Liver wt. g/1000 gbw	Intestine wt. g/1000 gbw	Intestine length cm	Cacae length cm
Day 1-14						
Feed restriction	21.17±4.47	18.10±1.42	16.00[b]±0.12	28.67[b]±0.67	59.57±3.48	6.67±0.67
ZnO, 2%	15.53±6.76	12.47±1.01	29.37[a]±2.62	43.30[a]±2.03	69.70±1.40	7.00±0.58
ZnO, 3%	14.57±1.98	15.17±3.42	19.97[b]±0.58	38.87[ab]±0.58	74.33±3.18	8.17±0.17
Fasting	19.77±1.55	18.40±1.08	16.07[b]±0.77	32.13[b]±2.74	63.23±7.30	6.50±0.50s
Day 15-32						
Feed restriction	11.50±4.32	17.07±2.41	17.17±1.20	37.23±3.37	67.20±4.06	7.00±0.58
ZnO, 2%	10.54±5.30	14.43±0.79	15.47±0.27	36.23±1.84	69.57±7.11	7.50±0.58
ZnO, 3%	15.53±10.03	19.83±1.98	17.57±0.74	42.47±2.45	76.40±5.60	7.33±0.88
Fasting	26.70±7.70	17.87±3.26	15.33±1.56	38.33±4.07	67.50±6.98	6.17±0.73

Means in each column with different superscripts are significantly different ($p<0.01$). [1]n = 3

results are in agreement with those reported by Hassan (2003), who reported body weight reduction of laying hens fed on 5000 to 20.000 ppm ZnO. However, these findings are in contrast to those of Brake and Thaxton (1979), McCormick and Cunningham (1984), and Berry and Brake (1985) who reported a 17% body weight loss and higher FC with feeding ZnO 2% for one week. FC results also showed that hens treated with feed restriction consumed more feed 75 g/hen/day, as compared to the other force molting methods; 72.6 and 73.0 g/hen/day for ZnO 3% and fasting, respectively. The reduction in FC during the first two days of this period could be a result of appetite loss, which was recovered and hens consumed the assigned amount of feed thereafter. Our results agree with others, Hassan (2003) reported a reduction in FC of laying hens fed on 5000 to 20.000 ppm ZnO. Feed intake for ZnO treated groups was lower in both of 2 or 3% groups as compared to the other treatments. These findings are related to those of (McCormick and Cunningham, 1984) 12.6 g/day for hens that fed 20000 ppm zinc oxide for 8 days, 23 g/day for hens that fed high dietary zinc oxide (Mohamed, 1990), and 42 g/day during the first month for hens that received dietary zinc diet (Shippee *et al.*, 1979). Hassan (1996) concluded that using dietary zinc oxide, for hens, affected the feed center in hypothalamus leading to decrease in feed consumption and anaroxy syndrome. Force molting methods showed no significant effects on mortality percentage during this experimental period.

Body weight, weight loss and mortality percentages during the 33-58 days period, did not differ due to treatments effect. However, similar to the 1st period, ZnO 3% showed the higher body weight loss 5.4%, followed by the ZnO 2% of 5.2% when compared to the other force molting methods. Also, hens consumed equally all of the assigned feed amounts during this period. Mortality

Table 7: Effect of force molting methods on the weekly egg production of broiler breeder hens throughout the 4th experimental period (day 59-129)

Week	Standard*	Restricted feed		ZnO 2%		ZnO 3%		Fasting	
	H.H%	H.D%	H.H%	H.D%	H.H%	H.D%	H.H%	H.D%	H.H%
1	5	4.57	4.48	3.14	3.17	4.71	4.50	3.71	3.5
2	16	16.00	15.60	15.00	15.15	14.40	13.70	18.80	17.80
3	30	31.00	30.70	36.20	36.20	24.00	23.00	35.00	33.40
4	45	39.50	38.80	56.00	50.60	34.00	32.80	51.00	48.50
5	60	48.90	47.90	60.70	60.30	47.00	47.00	60.00	60.10
6	75	57.00	56.60	76.00	66.40	57.30	57.10	63.00	62.30
7	81	59.00	59.00	67.00	66.70	58.00	57.50	66.00	64.00
8	81	59.40	59.40	56.70	56.70	57.20	57.20	68.40	68.10
9	80	63.00	61.20	70.00	67.80	60.50	59.00	67.00	70.10
10	70	63.60	63.10	69.90	69.90	61.40	61.00	72.90	72.00
Overall mean	54.30	44.19	43.60	51.10	50.20	41.90	41.30	50.60	49.90

*Standard = first year production

percentage was also not affected by any of the treatments.

It is clear from (Table 4), that both fasting and restricted feed methods resulted in a rapid cessation of egg production throughout the 1st experimental period. As hens reached 0% production within 8 days for these two methods, however, ZnO 2 and 3% reached 0% egg production after 10 to 12 days. These findings agree with those of Scott and Creger (1976 and 1997) and Shippee *et al.* (1979). On the other hand, McCormick and Cunningham (1984) reported rapid reduction in egg production using ZnO. Cunningham and McCormick (1985) also reported that hens reached 0% production in 5 to 7 days using ZnO while hens fed on feed removal program took 5 to 8 days. Berry and Brake (1985) explained these findings to be potentiated by the 8 hr. photoperiod and could be related to the amount of body weight loss and the degree of involution of the ovary and oviduct experienced by each group. Our results reported herein are documented by the findings of Rose and Campbell (1986), reporting that fat birds tend to cease production sooner and laid fewer during the period after feed removal.

During the 1st experimental period, although ovary weights were not significantly affected by any of the treatments, it is noticeable that ZnO 2% had the heaviest value followed by the fasting method, 2.0 and 1.77 g/1000g bw., respectively. Similar results were obtained with oviduct. Force molting methods significantly affected ($p<0.05$) oviduct weight, while it had no effects on oviduct length (Table 5). Feed restriction method had the lowest oviduct weight 5.27 g/1000g bw., while ZnO 2% had the heaviest value 7.57 g/1000g bw.

Force molting methods within the 2nd experimental period had no significant effects on the reproduction system, (Table 5). Ovary weights ranged from 0.90 to 1.57 g/1000 g bw, with the heaviest value at the ZnO 2%. Oviduct weights were 2.575, and 2.37 g/1000 g bw for restricted fed and ZnO 2% respectively, and 2.07 g/1000 g bw fir both ZnO 3% and fasting.

Effect of force molting methods on the reproductive system of broiler breeders during the 3rd experimental period is illustrated in (Table 5). As obtained within pervious periods, ovary weights were not affected by treatments. However, Zn O 3% followed by ZnO 2% showed the highest values of 1.10 and 1.07 g/1000 g bw., respectively. All of the force molting methods were statistically significant ($p<0.05$), and almost similar except for the ZnO 3% treatment which was the heaviest 3.53 g/1000 g bw., a similar trend was also observed with the oviduct length.

Effects of applying different molting methods on the digestive tract are presented in (Table 6). During the period of 1-14 days of age, only liver and intestine weights were significantly affected ($p<0.05$). ZnO 2% exhibited higher weights for both parameters 29.37 and 43.30 g/1000g bw., respectively as compared to the other force molting methods. In general, greatest loss weights can be observed in fat pad, liver and kidney, such losses increased by increasing the dietary zinc oxide dose, this is similar to our results reported herein as increasing ZnO from 2 to 3% resulted in a reduction in liver weight from 29.37 to 19.97 g/1000 g bw., respectively. Similar results were reported by Hassan (1996), Brake and Thaxton (1979), Berry and Brake (1985) who noticed that liver weight was lighter in hens fed zinc oxide than control. The reduction in liver weight in the other treatments could be attributed to removal of liver energy stores "glycogen sand lipids". Also, due to the loss of estrogen-dependant egg component synthesis, which is dependant on ovarian steroids such as estrogen (Sturkie, 1976). It is important to note that the minimum liver weights of ZnO 3% and fasting were coincided with minimum body weights, and the ovarian regression occurred simultaneously with body weight reductions. This should result in loss of ovarian steroids and subsequently a reduction of liver synthesis of yolk precursors affecting ovary oviduct weights and length.

Table 8: Effect of force molting methods on the performance of broiler breeder hens throughout the 4th experimental period (day 59-129)

Treatment	Feed consumption	Body weight	Days to 50% prod	Feed efficiency	Mortality
	g/hen/day	g	g	feed/g egg	%
Feed restriction	173± 0.0	3778.0±63.9	104	4.38^{b}±0.15	4.00
ZnO, 2%	173± 0.0	3677.5±62.8	95	3.80^{a}±0.08	1.00
ZnO, 3%	173± 0.0	3740.0±70.8	105	4.64^{b}±0.11	2.80
Fasting	173± 0.0	3842.0±78.4	95	3.83^{a}±0.08	3.80s

Means in each column with different superscripts are significantly different (p<0.01).

Table 9: Effect of force molting methods on egg quality of broiler breeder hens throughout the 4th experimental period (day 59-129)

Treatment	Egg weight g	Shell weight g	Shell %	Shell thickness mm
Feed restriction	70.25±0.29	6.50±0.16	9.20	0.355±0.061
ZnO, 2%	69.70±1.82	6.07±0.21	8.70	0.366±0.048
ZnO, 3%	68.30±1.01	6.36±0.14	9.33	0.365±0.044
Fasting	71.40±1.68	6.28±0.20	8.79	0.345±0.046

Each number represents 120 eggs.

The effect of applying force molting methods on the digestive system of broiler breeders during 15-32 days is represented in Table 6. Results indicated no significant effects (p>0.05) on all studied parameter, including abdominal fat, gizzard, liver, intestine weights. Effects of different force molting methods on egg production, feed consumption, body weight were not different due to different treatments (Table 7 and 8). On the other hand, days to 50% egg production were significantly different (p<0.05) with the feed restriction and ZnO 3% methods equally took longer time to reach 50% production, 104 and 105 days as compared to fasting and ZnO 2% methods 95 days each, respectively. (Shippee *et al.*, 1979) reported no differences in egg numbers produced with ZnO treated birds as compared with the conventionally molting methods. On the other hand, McCormick and Cunningham (1984) found a greater number of eggs produced with fasted hens as compared to the ZnO treated hens. Our data reported herein, indicated that peak production for all groups occurred during the week 10, ranging from 63 to 72.9% and was not significantly different (Table 7). It s also, noted that fasted hens or ZnO 2% ones utilized feed more efficiently (p<0.05) as compared to those of the restricted or ZnO 3% hens respectively.

There were no significant differences (p>0.05) of egg weights for treated hens with different force molting methods (Table 9). However, it worth noting that egg weight from the two ZnO levels 2 and 3% were numerically higher as compared to those corresponding values of the other two methods; fasting and feed restriction. Several researchers have stated that force molting had little or no influence on egg weight (Noles, 1966; Nakazawa *et al.,* 1970; Roland and Bushong, 1978). Furthermore, force molting methods had no significant effects on shell weight, shell percentage or shell thickness (Table 9). It also important to note that the shell thickness reported herein is with in the normal range for both hatched or table eggs; 0.380 and 0.330 mm., respectively. This is in correspondence with the results of Swanson and Bell (1975), and Hembree *et al.* (1980), as both reported that force molting treatments should result in production of egg with good quality characteristics. Furthermore, they concluded that induced molting that result in a competed cessation of lay and reproductive involution will provide satisfactory post molt performance in regard to egg shell quality. It is concluded that force molting can be successfully conducted with very good results in regard to egg production, feed consumption and egg quality.

References

Ahmad, A.H. and D.A. Roland, Sr., 2003. Efficient Feeding of Molted Hens with Different Feeding and Formulation Methods. Int. J. Poult. Sci., 2: 383-388.

Baker, M., J. Brake, and G.R. McDanial, 1983. The relationship between body weight loss during an induced molt and post-molt egg production, egg weight, and egg shell quality in caged layers. Poult. Sci., 62: 409-413.

Bell, D., 1995. Forces that have helped shape the U.S. egg industry: the last 100 years. The Poult. Tribune, Sept., pp: 30-43.

Berry, W.D. and J. Brake, 1985. Comparison of parameters associated with molt induced by fasting, zinc, and low dietary sodium in caged layers. Poult. Sci., 64: 2027-2036.

Berry, W.D. and J. Brake, 1987. Post performance of laying hens molted by high dietary zinc, low dietary sodium and fasting: Egg production and egg shell quality. Poult. Sci., 66: 218-226.

Brake, J. and P. Thaxton, 1979. Physiological changes in caged layers during a forced molt. 2. gross changes in organs. Poult. Sci., 58: 707-716.

Cunningham, D.L. and C.C. McCormick, 1985. A multi-cycle comparison of dietary zinc and feed removal, molting procedures, production and income performance. Poult. Sci., 64: 253-260.

Duncan, D.B., 1955. Multiple range and multiple F.test. biometrics 11:1-42.

Hembree, D.J., A.W. Adams and J.V. Craig, 1980. Effects of force molting by conventional and experimental light restriction methods on performance and Agonistic behavior of hens. Poult. Sci., 59: 215-223.

Hassan, M.S., 1996. Physiological changes in laying fowl during force molting. M. Sc. Thesis, Fac. of Agric., Cairo Univ, Egypt.

Hassan, M.S.H., 2003. Some productive and physiological responses for using dietary zinc oxids on laying hens. Egypt. Poult. Sci., vol. 23, (II): 299-312.

Holt, P.S., 1993. Effects of induced molting on immune responses of hens. Br. Poult. Sci., 33: 165-175.

McCormick, C.C. and D.L. Cunningham, 1984. A high dietary zinc and fasting as methods of forced resting. A performance comparison. Poult. Sci., 63: 1201-1206.

Mohamed, A.T., 1987. Zinc oxide as a resting agent and its influence on layer performance. M. Sc. Thesis, Fac. of Agric., Cairo Univ., Egypt.

Mohamed, F.R., 1990. Studies on molting and its relation with egg production in the fowl. Ph. D. Thesis, Fac. of Agric., Cairo Univ., Egypt.

Nakazawa, M.K. Futura and T. Fuke, 1970. Studies on the forced molting in layers. Effect of force molting in autumn on the performance of the layer. World's poult. Sci., 26: 821 (abstr.).

Noles, R.K., 1966. Subsequent production and egg quality of force molted hens. Poult. Sci., 45: 50.

Palafox, A.L. and H.A. Elodie, 1980. Effect of zinc toxicity in laying white leghorn pullets and hens. Poult. Sci., 45: 50.

Roland, D.A. Sr. and R.D. Bushong, 1978. The influence of force molting incidence of uncollectable eggs. Poult. Sci., 57: 22-26.

Rose, S.P. and V. Campbell, 1986. Fatness of laying hens and induced molting methods regimens. Br. Poult. Sci., 27: 369-377.

SAS Institute, 1996. SAS user's guide: Statistics, version 6.12. SAS institute Inc., Cary, NC.

Scott, J.T. and C.R. Creger, 1976. The use of zinc as effective molting agent in laying hens. Poult. Sci., 55: 2089 (Abstr.).

Scott, J.T. and C.R. Creger, 1997. The use of zinc as an effective molting agent in laying hens. Poult. Sci., 76: (Abstr.).

Shippee, R.L., P.E. Stake, U.K. Koehn, J.L. Lambert and R.W. Simmons, 1979. High dietary zinc or magnesium as forced-forced-resting agents for laying hens. Poult. Sci., 58: 949-954.

Snedecor, G.W. and W.G. Cochran, 1967. Statistical methods. 6th edition. Iowa state Coll. Press, Ames, IA.

Sturkie, P.D., 1976. Endocrine influence on lipid metabolism. Avian physiology 3rd. ed. P.21 Sturkie, ed. Springer-Verlag, New York, NW.

Swanson, M.H. and D.D., Bell, 1975. Force molting of chickens. IV. Egg quality, California Coop. Ext. Serv. L-2810.

USDA/NASS, 1996. Chickens and Eggs. Washington DC. Jan., 31,1996.